RESPONSE ON CENTERS OF ENDEMISM, RARITY, AND BIODIVERSITY AND HOT SPOTS

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I. INTRODUCTION

What is the issue being addressed?

This report provides additional explanation of the development, and potential use, of maps of centers of concentration and hot spots of species rarity, endemism, and richness ("biodiversity"), from the Terrestrial Ecology Staff's ecological assessment.

II. CENTERS OF ENDEMISM, RARITY, AND BIODIVERSITY AND HOT SPOTS

A. What are they?

The Terrestrial Ecology Staff's ecological assessment of the interior Columbia Basin project area included an effort to identify centers of concentration, and local hot spots, of (a) species rarity and endemism, and (b) high species richness (denoted on the maps as "biodiversity"). Centers of concentration and hot spots were identified separately for plants and for animals. Hot spots are strictly subsets of the centers of concentration, where the greatest collection of rare or endemic species, or where highest species richness (number of species), might be found.

B. What is the scientific basis for identifying such centers of concentration and hot spots?

The conservation biology literature contains many examples of identifying such areas as vital facets of conservation planning for at-risk species or environments. The national Gap Program of USDI Fish and Wildlife Service has used the concept of centers of concentration and hot spots as fundamental aspects of their conservation planning work by identifying areas of "gaps" where conditions for high species concentrations or hot spots would not necessarily be conserved over time (e.g., see Csuti and Scott 1991, Flather et al. 1997, Kiester et al. 1996, Scott et al. 1991a, Scott et al. 1991b, Scott et al. 1993). Such work has aided conservation planning in many states, for example Idaho (Caicco et al. 1995).

In other examples, Winston and Angermeier (1995) evaluated the conservation value of areas using centers of high population density. Neitlich and McCune (1997) located "hot spot" areas of high diversity of epiphytic lichens in young forests for helping prioritize conservation activities. Prendergast et al. (1993) used hot spots of diversity and rare species to help build conservation strategies. And Willliams et al. (1996) compared richness hot spots, rarity hot spots, and other areas to help in conservation planning of birds in Great Britain. Many other examples can be found.

In most of these examples (and others), the identification of centers and hot spots was intended to aid management priorities, not to provide the sole means of ensuring conservation. Thus, such approaches are only one part of a broader tapestry of conservation activities and assessments.

Additional information on the scientific basis for identifying centers of concentration was reviewed by Marcot et al. (in prep.) and was presented in the internal task group report on natural areas by Diedrich et al. (no date [1994]; see Administrative Record Material).

C. How were they developed?

The maps of centers of concentration were developed as part of expert panel meetings. The procedure was described in Marcot et al. (in prep.):

Expert panels of agency and non-agency scientists were convened between [October 1994 and March 1995 for plants and] March and May of 1995 [for animals] to identify areas of rare and endemic populations of plant, invertebrate, and vertebrate species. [The plants portion of this mapping effort was conducted as part of the plant species panels, not separately as was done for the animals portion.] The panels of experts produced maps showing areas of high numbers of rare or locally or regionally endemic species and of areas having unusually high biodiversity (total number of species). Separate maps were created for plants and animals (aquatic and terrestrial invertebrates and vertebrates). We then overlaid the maps to determine particularly rich "hot spots" of endemism or biodiversity areas; hot spots were defined as areas where three or more endemism or biodiversity areas of individual taxonomic groups intersect. Thus, there are fewer hot spots than taxon-specific endemism or

biodiversity centers.

Additional information on instructions to panelists can be found in the ICBEMP administrative record (including letter to panelists from Elaine Zieroth, dated 5 April 1995). The instructions explicitly noted that some steps in identifying centers "require a finer scale assessment" than the project allowed (Administrative Record material, see below for citation). The panel procedures included providing the experts with lists of species identified in previous species panels as locally or regionally endemic, and lists of vertebrate species with some status as rare, endangered, sensitive, or species of concern by federal and state agencies. It was identified that mapping vertebrate centers, especially for wide-ranging species, will be difficult, and that the individual panels would discuss how to proceed. Specific expert panelists were listed in Marcot et al. (in prep.) and in the Administrative Record material. Additional information on the criteria used for identification of centers of concentration and hot spots can also be found in the internal task group report on natural areas by Diedrich et al. (no date [1994]; see Administrative Record Material).

Four classes of centers of concentration were identified:

Centers of concentration of rare or endemic species:

(1) of plants (these include rare plant communities in Montana)

(2) of animals (vertebrates)

Centers of concentration of biodiversity (high species richness or species counts)

(3) of plant taxa (species and selected rare subspecies or varieties)

(4) of animal taxa (species and selected rare subspecies).

Among these four classes of centers of concentration, many individual polygons representing these classes were drawn on maps of the assessment area.

The centers of concentration were developed based on panelists' knowledge of the location of rare or endemic species or high species richness, and in the locations of environments containing such species. For the animals areas, the panelists' drawing of these maps was done over a short time and mostly based on their individual knowledge of areas and species locations. For the plant areas, the criteria used for drawing centers of concentration were variable; details are presented in the administrative record (also see below).

An example of the plant panel process in Montana was that centers of species rarity and endemism of plants were drawn based on panelists' field experience and knowledge of distribution data. Centers were delineated on maps to circumscribe "relatively large" numbers of local or regionally endemic species, not just populations of one endemic species. The application of the mapping criteria necessarily varied by geographic area, because of the variation in density of rare or endemic plant species among areas. In Montana, the panelists used Heritage Program G1-G3 endemism classes and delineated centers even if only 2 or 3 rare or endemic species occurred in an area, since Montana and the northern Rocky Mountains are not a region of particularly high plant endemism in general compared to other places such as the Great Basin or California. Thus, a center of plant species rarity or endemism in Montana should not be interpreted the same, in terms of numbers of endemic plant species

or size, as one in eastern Oregon where many more plant endemics occur, many of which are highly restricted geographically (e.g., in Leslie Gulch).

Centers of biodiversity of plants were interpreted by panelists as areas that contain "large" (not numerically specified, but relative to a particular state or geographic area) numbers of endemic or state rare species. In Montana, for example, these included state rare plants with Heritage Program ranks of S1-S2.

Thus, the key differences between the two kinds of centers for plants were: centers of plant endemism and rarity were where 2 or more geographically restricted (G1-G3) species occur, whereas centers of plant biodiversity were where many rangewide or state rare (S1-S2) species occur. Some panels might have expressed centers of biodiversity using not just state rare species, but other species as well.

The centers of concentration were then combined in GIS to produce the hot spots.

Thus, in Montana, individual range maps of vertebrate species were not yet available and therefore were not used to help identify the centers and hot spots. At that same time, the range maps were in the process of being developed, often by the same experts who participated in the panels to map centers of concentration. Thus, the centers of concentration and hot spot maps were developed from panel recommendations.

D. What do they represent?

The centers of concentration and hot spots were intended as a first approximation of identifying areas with particularly diverse collections of rare or endemic species, or areas with high species richness. Some maps were produced as part -- often as the final tasks -- of expert panels convened to otherwise provide details of species' individual ecologies. The maps were intended from the beginning to provide a rough guideline -- at the broad scale as sketched by experts -- on areas that might invite further, more detailed inspection by EIS teams, agencies, or local administrative units.

The maps of centers of concentration and hot spots are expressly only one component of biodiversity; other components deal with species-specific trends and habitat requirements, species' ecological functions, and many other facets discussed in Marcot et al. (in prep.).

Importantly, the centers and hot spots do not represent field-verified boundaries. Nor do they represent locations requiring any one, specific management activity (such as "protection" or "reservation" or "restoration") to ensure conservation of rare, endemic, or many species. Nor do they represent the best possible refinement of identifying such areas. They do represent an attempt to denote on maps areas that may be important to multiple species, and that might be candidates for research natural areas or other natural area designations pending further local assessment and refinement.

It is vital to understand that conservation, in some sense, of centers of concentration and hot spots does not by itself necessarily ensure long-term viability of associated taxa and ecological communities. That is, estimates of the occurrence of species, subspecies, or rare ecological communities by themselves provide no indication of an environment's capability to support long-term persistence of the associated populations and communities. In some cases, for example, hot spots might omit important population strongholds for some species. Thus, centers and hot spots should be viewed as a "community" level approach that is complementary to -- not a replacement for -- species-specific evaluations and conservation actions.

E. Do the answers differ by species group?

Yes. The areas for animals were delineated using more consistent criteria than used for plants. For plants, the scale of delineation and level of knowledge of the area varied among panels. But all areas, for plants and animals alike, should be viewed only as first approximations requiring local refinement and validation. (A potential procedure for this is discussed below.) The procedures used to identify the plants portion were not standardized across all expert panels and geographic areas.

III. INTERPRETATION OF THE CENTERS AND HOT SPOTS

A. How can managers best use this information in its present form? (does this answer differ by species group?)

As presented, the centers of concentration and hot spots should be viewed by managers as cues to consider some areas as potentially having some unique environments for rare or endemic species, or that would hold a high richness of species. In the case of plants, we found the distributions of many species are poorly described and further work is needed to clarify the boundaries of their centers of concentration. Centers of concentration and hot spots of rare or endemic species and high species richness likely contain unique, scarce, and possibly fragile environments and plant and animal communities not typically found elsewhere.

We fully expect that, upon closer inspection with local data and experience, many of the boundaries of the centers and hot spots would change. Perhaps some would be expanded or added, and others reduced or eliminated. Remember, the intent of the project was to provide very coarse-grained and broad-scale information only.

B. How can managers refine the centers and hot spots? -- A "step-down protocol."

This cuts to the heart of using much of the assessment information which was gathered at the broad scale: a "step-down protocol" would be necessary to refine results and tailor to local data and conditions at finer scales of geographic resolution.

The objectives for a "step-down protocol" is to make efficient and full use of local information on the distribution of species, their habitats, and rare plant communities, at scales of finer spatial resolution than was possible in the terrestrial ecology assessment of ICBEMP. Further, a local reevaluation should focus on individual centers of concentration and less on the composite, overlapping hot spots.

A step-down protocol for refining the centers and hot spots might include the following steps:

Step 1. Locate centers of concentration from the ICBEMP ecological assessment, on individual National Forests or BLM Districts.

The purpose of this step is to locate all the centers of concentration that were identified in the terrestrial ecology assessment of ICBEMP.

As defined and used in the assessment, there are four classes of centers of concentration: (1) centers of concentration of rare or endemic species of plants (these include rare plant communities); (2) centers of concentration of rare or endemic species of animals (vertebrates, although invertebrates could be added as local information permits; see below); (3) centers of concentration of biodiversity (high species richness or species counts) of plant taxa (species and selected rare subspecies or varieties); and (4) centers of concentration of biodiversity (high species richness or species counts) of animal taxa (species and selected rare subspecies).

Remember that the plant information is highly variable. Maps are available from the ICBEMP office in Walla Walla; the map of hot spots also appeared in USDA (1996, p. 98) and in Marcot et al. (in prep.).

Step 2. Determine the elements (taxa and, for plants, communities) and factors contributing to the center of concentration.

The information for centers of concentration can be found in the Administrative Record material (see below); this information includes lists of species considered overall and for each center of concentration. (As it also helps in this step, descriptions of the composite hot spots can be found listed in a table in Marcot et al. (in prep.), although, again, we advocate focusing on centers of concentration rather than just the hot spots.)

Overall, the factors contributing to delineating centers of concentration included (a) scarce or unique environments and habitats, particularly rare plant communities (such as discussed in Marcot et al., in prep.) and scarce or highly localized environments, and (b) locations of rare, endemic, threatened, endangered, or sensitive species, or species of concern. Note that, because of time limitations, for item (b), "element occurrence" records from the Heritage Program databases were not specifically used for the ICBEMP assessment.

Step 3. Revisit and refine, if necessary, area boundaries.

The purpose of this step is to use available information at finer scales of spatial resolution than was possible in the terrestrial ecology assessment of ICBEMP, to refine, eliminate, or add boundaries of centers of concentration based on local data and knowledge.

Area boundaries can be refined based on (1) known field occurrence of taxa (plants and animals) and rare plant communities, (2) overall distributional ranges of taxa (plants and animals) and rare plant communities, and (3) occurrence or expected distribution of habitat for taxa (plants and animals) and environmental conditions for rare plant communities. Ideally, all three kinds of information would be used, where available.

For the purpose of delineating centers of concentration of rare or endemic species (including selected rare or endemic subspecies or plant varieties), taxa addressed here would include rare or endemic taxa (at least focusing on locally endemic taxa as defined and listed in Marcot et al., in prep.). It may be useful to delineate centers of concentration of animals separate from those of plants, and to include, where local data permit, any information on invertebrates in the animals centers.

For the purpose of delineating centers of concentration of biodiversity (high species richness), all taxa considered in the assessment (Marcot et al., in prep.) should be included. This includes all vertebrate species, and rare vascular plant taxa.

Also engage local experts. If Gap Program data on species ranges are not available, then one can use -- at least for the vertebrates -- the refined and updated set of species range maps produced by the Science Integration Team (maps are available through the ICBEMP office in Walla Walla, Washington). Chances are that the specific boundaries shown on the existing centers and hot spot maps will change once higher-resolution, location-specific, and species-specific range data or location data are used.

This finer-resolution information could be combined on maps to refine and delineate centers of concentration. In using known field occurrence (information source (1) listed above), the intent is to simply demarcate areas with known presence of a species or taxon, not to count the number of observations (or plant element occurrences) as some index to population size or density. (Such indexes may be flawed, particularly if based on opportunistic observations and data sets in which the absence of an organism has not been really determined.)

Step 4. Describe the environments and status of the taxa contained within the newly-delineated or refined area boundaries of centers of concentration.

The purpose of this step is to have a catalogue of the environments and species' habitats within each of the refined centers of concentration areas, from which to next build management considerations.

To be most helpful, describe the environments in terms that can be related to available inventory information such as vegetation surveys and maps available at administrative units.

Also, the SIT's evaluation of EIS alternatives -- which was completed after the basic ecological assessment (including the delineation of centers and hot spots) -- can be used as a source of information on the historic, current, and potential future habitat and population outcomes, for wildlife (vertebrate) and plant species included in the centers of concentration (Lehmkuhl et al., in press). The evaluation of EIS alternatives did not, however, analyze most endemics because of their limited distribution, instead recommending them for a finer-scale analysis. This pertains to most rare plants but fewer vertebrates (habitat trends and population outcomes of invertebrates were not addressed in the evaluation of alternatives). That finer-scale analysis of individual endemic species may tie in nicely with the step-down protocol for locally refining centers and hot spots. The evaluation of EIS alternatives would, nonetheless, provide a good reference for aiding in the ranking of selected species for conservation attention. That is, if all species considered in the delineation of a center of concentration are not of much concern, then that area may become a lower priority for any special management. Note, however, that centers of concentration for plants include consideration for rare plant communities, which were not part of the evaluation of EIS alternatives; thus, rare plant communities should be evaluated in addition to using information from the evaluation of EIS alternatives.

As well, the terrestrial ecological assessment (Marcot et al., in prep.) could be used to highlight any areas in which there is significant presence of listed species.

Step 5. Determine if already-scheduled or planned activities would suffice to conserve environments within the centers of concentration, as identified in step 4.

The purpose of this step is to determine if any special management consideration is needed to help ensure conservation or, when appropriate, restoration of environments and species' habitats within centers of concentration. Further purposes are to prioritize areas for conservation consideration if indeed additional management attention is warranted; and to determine what kinds of management activities would be consistent with maintaining or restoring desired environments and species' habitats.

Evaluate the environments and species' habitats described in step 4, within the specific boundaries and locations refined and identified in step 3, in terms of how well they can be conserved (maintained or, if necessary, restored), given existing or proposed management and planning activities at the Forest level (perhaps as resulting from application of the ICBEMP EIS). Again, the analysis of EIS alternatives (Lehmkuhl et al., in press) may provide useful information on effects of past management relative to the judged outcomes on the viability of selected plant and vertebrate species.

Remember, it is not necessarily expected that all centers of concentration would either need to be conserved under selected planning directions, or that a strict hands-off approach would necessarily always be the best tactic should conservation of conditions be desired. Rather, such conditions and needs should be evaluated on a Unit-, or in some cases, a center- and site-specific basis, in context of other scheduled activities and anticipated disturbances (especially fires, but also consider invasion of noxious weeds and other potential disturbances).

Step 6. Describe needed activities within the areas to help ensure their conservation.

The purpose of this final step is to identify management measures needed for higher-priority centers of concentration where existing or planned forest-wide activities would not suffice to ensure maintenance or restoration of environments and habitats for associated elements. The intent of such conservation measures is to help ensure long-term persistence of environments and habitats for taxa and rare plant communities, which in turn should help ensure improved likelihood of persistence of taxa and communities.

It is not expected that viability of associated species would be assured, except for the perhaps uncommon cases where all of a species' distributional range and habitats are located within center(s) of concentration. That is, to ensure viability of species, it is likely that additional land areas, environments, and habitats outside the centers of concentration would need some attention as well. If the manager chooses to delineate centers of concentration for the purpose of species viability management, then they may wish to ensure that the centers are adequate in size and inclusiveness of environments and habitats to encompass all such conditions used and selected by the species of interest. Such an approach may be thought of as a community approach to "survey and manage" species (as defined for the Northwest Forest Plan).

If it is determined that specific centers of concentration are to be conserved, and that scheduled or planned activities might otherwise have adverse effects, then describe the center- or site-specific activities that would best maintain or restore (if necessary) conditions. Such activities may include reservation, active management, etc., depending on environmental conditions, local species requirements, site history, etc. If the environments to be conserved are particularly sensitive (such as some wetlands or thin-soil environments), consider potential inclusion in various kinds of natural areas. Denote the level of confidence in the information leading to such actions, and the kinds of monitoring that may help bolster knowledge, if needed.

The size of an area, and cumulative effects among activities, are both important considerations here. For example, a given management project affecting only a very small percent of the area of a center of concentration might be viewed differently than a project affecting a large percent. And additive effects of other, on-site (and off-site) activities might influence the degree of effect of a given management activity. The manager might consider the magnitude of an impact in relation to risk posed on the center, and this will at least depend on the size, pattern, and specific conservation value of a given center. These are the kinds of determinations that are best made with local and more refined information.

One other consideration for this step relates to the potential importance of connectivity either among centers of concentration or between centers and other particular land allocations or environments. The purpose would be to determine the degree to which environments, including species-specific habitats (e.g., dispersal habitat for vertebrates), are interlinked across a broader landscape area. On the other hand, if a center of concentration is to serve as an isolated environment without specific connectivity to other sites, then that too should be made clear.

C. Use of Heritage Program Data and Global and State Ranking

For plants, a step-down protocol as outlined above could be done for the entire interior Columbia Basin assessment area or for individual planning areas. Most important for plants would be specific use of Heritage Program (and related program) databases of "element occurrences" of known plant sites. For plants, too, the definition of the term "endemism" could be refined to match that of globally rare elements (both communities and plant taxa) as used by The Nature Conservancy. For refining maps of endemic plant areas, one might want to request occurrence density maps, that is, the number of plant element occurrences per county, township and range, etc., for those elements with a global ranking of G1, G2, or G3. For refining maps of biodiversity areas for plants or animals, one might want to map areas of high concentrations of global (G1, G2, G3 classes) and State (S1, S2 classes) listed rare elements alone, as well as biodiversity areas for elements of all rarity classes. Maps of high plant diversity at the country level could then be generated; alternatively, they can be mapped locally by 1-degree latitude-longitude blocks.

D. Caveats on a step-down protocol

Delineating centers of concentration for plants and animals might be useful for identifying major areas of special ecological value. However, they should be viewed as only one part of a broader conservation approach. Identifying and conserving appropriate environments within centers of concentration (and especially within hot spots) does not necessarily ensure long-term viability of associated populations and communities, only that locally unique sites are accounted for.

Thus, the manager might want to be very clear as to the strengths, weaknesses, unknowns, uncertainties, and major assumptions underlying any such step-down approach. These are listed in Table 1.

Also, the step-down protocol listed above is largely qualitative, as written. Local implementation of it would entail quantifying the process, such as identifying the appropriate scale of resolution (minimum polygon size or pixel size) of maps. This might vary by dint of available data.

The manager might also wish to pay at least equal attention to centers of concentration and any composite, overlaid, resulting "hot spots." That is, do not just focus on hot spots (from the current assessment maps, or from any local revisions by using the above step-down protocol). The overlap of centers of concentration to produce hot spots may dilute the use and power of those areas for identifying polygons important to biodiversity or rare or endemic species. The proportion of included ranges of most species would likely be lower in hot spots than in centers of concentration. This loss factor may be greater when widely varying taxa are included in single hot spots.

As well, centers of concentration of rare or endemic wide-ranging vertebrates may have limited management significance. Thus, any centers of concentration derived solely from such taxa may have far lower priority for management considerations, than for centers of concentration delineated for more narrow-ranging vertebrates. This would be especially true if the included species are not thought to be of great concern.

E. Postscript on the step-down protocol

The "step-down protocol" described above is only one such procedure that might help tier the broad-scale assessment findings to local conditions. Similar methods might aid in applying many other facets of our assessment findings, such as providing conditions to ensure key ecological functions of organisms that are important to maintaining overall ecosystem processes such as soil productivity. The intent would be to provide a quick refinement of the broad scale results, not to institute major new analyses.

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information coded to areas on map), documentation submitted by Elaine Zieroth.

Table 1. Strengths, weaknesses, uncertainties, and major assumptions underlying a step-down approach to locally delineating centers of concentration and hot spots of species rarity and endemism and biodiversity for plants and animals.

Strengths

o delineates and identifies areas of unique ecological value contributing to (but not necessarily by itself ensuring) long-term persistence of associated taxa and ecological communities
o uses local information and the most current data (wildlife studies, sightings, plant element occurrences, etc.)
o better fits the specific conditions of the land than does a broad-scale, coarse-grained mapping as provided by ICBEMP

Weaknesses

o does not by itself absolutely ensure long-term viability of associated populations and ecological communities
o certain key population centers might not be included in such areas unless expressly added as part of the local delineation process of the step-down protocol

Uncertainties

o the specific long-term viability of individual populations included in the areas
o the degree to which local and long-term management activities provide for environments within such areas

Major Assumptions

o that management activities can be identified that prolong or restore environments within centers and hot spots, to help conserve associated taxa and ecological communities
o that analysis and conservation of endemic or rare taxa or ecological communities outside the centers and hot spots would serve to supplement overall conservation objectives
o local re-evaluation and delineation of centers and hot spots is not necessarily predicated on a strict reserve approach to management, but that local conditions might serve to guide appropriate management activities pursuant to overall planning goals